AUTOMATIC PREPROCESSING IN THE METHOD OF FINITE SPHERES

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In spite of the success of traditional finite element techniques, problems associated with the generation of a "good quality" mesh have resulted in the development of so-called 'meshfree methods' (some of these techniques have been reviewed in [1]). While the technique of generating a meshfree method is rather straightforward, the real problem lies with automatic preprocessing and efficient implementation [2]. In meshfree methods discretization of the computational domain is performed using nodal points. While a random placement of the nodes is not practical, as it would require expensive runtime neighbor search operations, the use of a finite element package creates more information than is necessary. In this paper we present a technique of generating the nodal points and defining the open cover for the method of finite spheres [1], a truly meshfree technique developed for the solution of boundary value problems on complex domains

In the method of finite spheres, the computational domain is discretized using a set of nodal points and the interpolation functions are compactly supported on spheres centered at these nodes. The computational domain is subordinate to the open cover generated by the spherical subdomains. A *valid cover* recognizes the underlying geometric boundaries of the domain and ensures that while each and every point in the domain is covered by at least one sphere, an excessive number of spheres do not overlap at any given point. It also ensures that the ratio of the maximum overlap of two spheres and the volume of the smaller sphere is less than unity.

We have developed a tree-based approach (quadtrees in 2D and octrees in 3D) for the generation of a valid cover for the method of finite spheres. The major advantages of such an approach are (i) it can be efficiently integrated with commercial solid modelers; (ii) it offers a spatial data structure that is very convenient for many topological and geometric operations as well as parallelization; and (iii) adaptive refinement can be easily implemented.

A balanced octree (with at most one-level difference between neighboring interior octants) is created and the computational nodes are placed at the centroids of the octants with the circumspheres of the octants serving as the "finite spheres". This construction automatically ensures an open cover. However, novel techniques have been developed to compute the intersections of the spheres on the model surface as well as the integrals in the Galerkin weak forms. We present several numerical examples demonstrating the effectiveness of the discretization scheme.

References

[1] S. De, and K. J. Bathe, "The Method of Finite Spheres," *Computational Mechanics*, v. 25, p. 329-345, 2000.
[2] S. De, and K.J. Bathe, "Towards an efficient meshless computational technique: the method of finite spheres", *Engineering Computations*, 18, 170-192, 2001.